TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 101.

COMPARING MAXIMUM PRESSURES IN INTERNAL COMBUSTION ENGINES.

By Stanwood W. Sparrow and Stephen M. Lee,
Bureau of Standards.

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Summary.

Thin metal diaphragms form a satisfactory means for comparing maximum pressures in internal combustion engines. The diaphragm is clamped between two metal washers in a spark plug shell and its thickness is chosen such that, when subjected to the explosion pressure of the engine, the exposed portion will be sheared from the rim in a short time. pressure comparisons may be based on the time required to shear diaphragms of the same thickness or on the thickness of diaphragm which will withstand the pressure for a definite length of time.

In connection with the internal combustion engine research at the Bureau of Standards, a very simple method of comparing maximum cylinder pressures has given satisfactory results. Thin metal diaphragms are used and these indicate when various sets of engine conditions result in the same pressure. For a numerical measure of that pressure, a more complicated apparatus is, of course, necessary.

As shown in Fig. 1, the diaphragm is mounted in a spark plug shell between two metal washers. The metal disk which serves as the diaphragm is selected of a thickness such that, when subjected to the explosion pressure of the engine, the exposed portion will be sheared from the rim in a comparatively short time. If this is to take place, two requirements must be satisfied. First, the pressure must be high enough to produce shear. Secondly, the pressure must endure long enough or be repeated often enough to effect the complete shearing of the center from the rim. It is evident from this second requirement that the time required for a disk to fail as well as its thickness should be considered when comparing pressures by this method.

Fig. 3 shows the time of failure for aluminum diaphragms of three thicknesses. A fourth diaphragm .046 inch thick had not failed at the end of 11 minutes. There is little need for any further explanation of the method of using this device. With the engine operating under a definite set of conditions the time required to shear a certain thickness of diaphragm is noted. Changes are then made to produce the conditions under which a comparison is desired and again the time required to shear a disk of the same thickness is noted. An alternative method of comparison is to substitute successively disks* of various thicknesses until one is found which fails in the same length of time as under the original engine conditions.

* The material of which all the disks are made should be the same and should have received the same treatment.

This device has been used on several occasions to demonstrate a fact frequently mentioned with reference to detonation, namely, that under certain conditions higher pressures result when firing from one spark plug than when firing from two. For these demonstrations the disk assembly was located as shown in Fig. 2 in an extra spark plug hole in the side of an otherwise standard Liberty cylinder. A thickness of diaphragm was selected which, with the engine operating with a fairly early spark would withstand the explosion pressures for over five minutes, provided the engine was fired from both plugs. If, however, after one minute of operation the ignition wire was removed from plug A and the engine fired from plug B alone the diaphragm would fail almost instantly. The experiment merely constitutes a rather striking illustration of how the failure of one spark plug may result in a disastrous increase of explosion pressure.

From the experiments made at the Bureau it appears that so long as diaphragms are made of the same material, check results can be obtained under the same engine conditions within rather close limits. In any event, the simplicity of the device commends its use for qualitative comparisons of a similar nature to that described above.

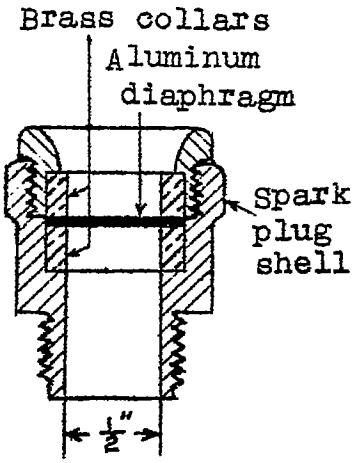

Fig. 1.

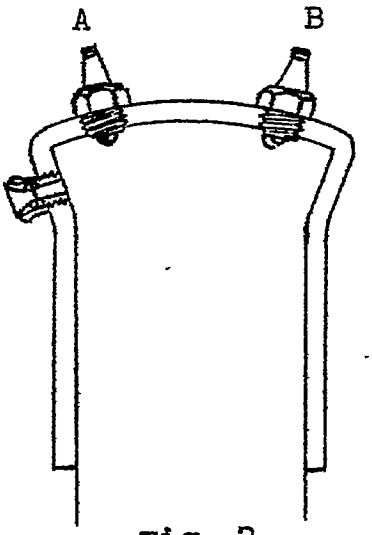

Fig. 2.

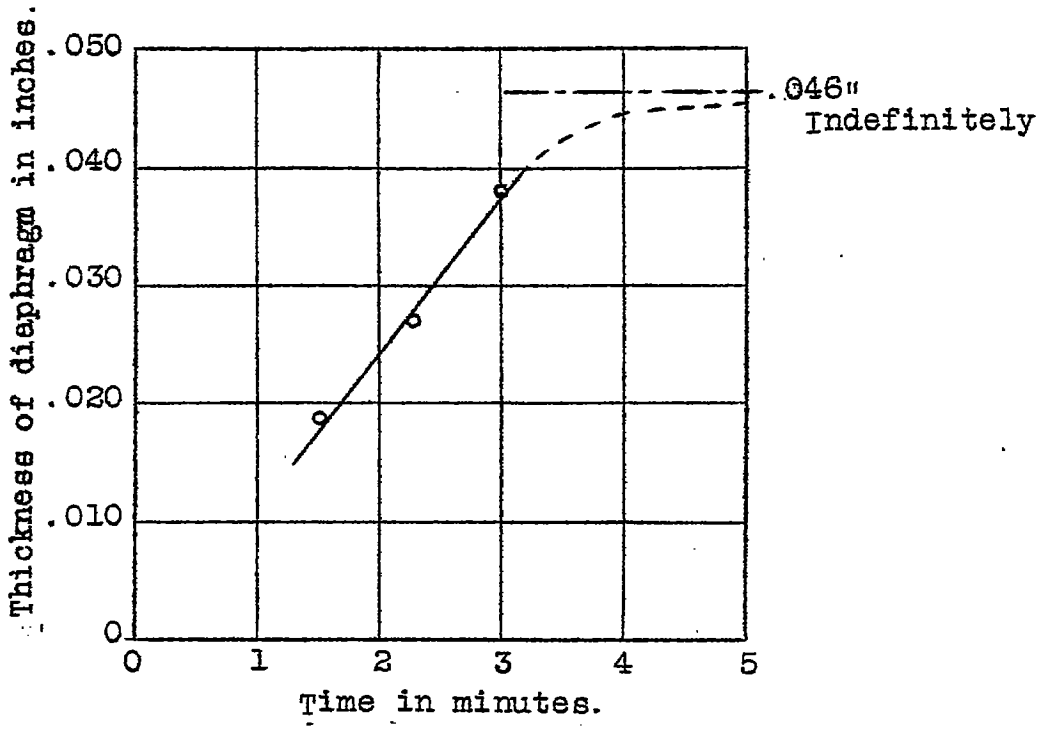

Fig. 3. Time for fracture. Engine speed, 1500 r.p.m.